COMPOSITION OF CANE JUICE

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Abstract

The typical composition of mixed juice extracted from cane is described with emphasis placed on South African values.

Keywords: Sugarcane juice, composition, processing

Introduction

Although mixed juice is often treated as a solution of sucrose in water, a variety of other extracted compounds may be present, some of which may affect clarification and subsequent processing. These compounds may be conveniently divided into the groups described in Table 1. Each group will be considered in detail.

Table 1

Juice composition

		% Bx	Table
Sugars	Sucrose	81-87	2
	Reducing sugars	3-6	
	Oligosaccharides	0,06-0,6	
	Polysaccharides[a,b] (including gums and dextrans)	0,2-0,8	
Salts	Inorganic salts	1,5-3,7	3
Organic non-sugars	Organic acids	0,7-1,3	4
	Amino acids	0,5-2,5	5
	Dextrans[a]	0,1-0,6	
	Starch[b,c]	0,11-0,5	
	Gums	0,02-0,05	
	Waxes, fats, phospholipids	0,05-0,15	
	Colourants	0,1	
Insolubles	Sand, bagasse, etc	0,15-1	

a Ravelo *et al.* (1991a, b)
b Bruijn (1966)
c Alexander (1954)

Carbohydrates

Table 2 shows the carbohydrates found in mixed juice. The most common consist of the monosaccharides glucose and fructose and the disaccharide, sucrose. Oligosaccharides and polysaccharides may be present depending on the age of the cane when harvested and deterioration during cane delays. These groups of compounds may have an adverse effect on processing efficency due to their influence on sucrose crystallisation (Morel du Boil, 1995; Ravelo *et al.*, 1991a). Only those oligosaccharides detected in the sugar crystal are reported in Table 2.

Polysaccharides are condensed monosaccharides which occur in the juice as starch, gums and dextrans. Formation of dextran is associated with infection of damaged, harvested cane by *Leuconostoc* bacteria (Egan and Rehbein, 1963) and also results in subsequent crystallisation and exhaustability problems (Bruijn and Morel du Boil, 1986; Koster *et al.*, 1992).

Table 2

Carbohydrate composition

Carbohydrate		Concentration
Monosaccharides (%)	Glucose	0.26-0,33
	Fructose	0,26-0,33
Disaccharides (%)	Sucrose	9,6-10,9
Oligosaccharides (% Bx)	1-Kestose	0.26-0,33
	6-Kestose	0,03-0,5
	neo-Kestose	0,01-0,4
	Theanderose	
Polysaccharides (% Bx)		0,3-1,3

Inorganic salts

The inorganic components of mixed juice consist of water and elements dissolved in it as ions, and parts of organic compounds (Table 3). Phosphates, magnesium and silica are the most important from a clarification viewpoint as these are partially removed. The other ions remain in solution and become concentrated with processing. The mineral content of the juice depends on cane variety and soil (McKaig and Fort, 1938). Care must be taken in comparing ash values in the literature since ashing techniques and temperatures affect the values obtained.

Table 3

Mineral concentration

Constituent		Concentration (% Bx)
Cations	Potassium (K_2O)[a,b]	0,77-1,31
	Sodium (Na_2O)[a]	0,01-0,04
	Calcium (CaO)[a,b,f]	0,24-0,48
	Magnesium (MgO)[a,b,f]	0,10-0,39
	Iron (Fe_2O_3)[a,d]	0,006-0,04
	Aluminium (Al_2O_3)[a,d]	0,005-0,17
	Copper (CuO)[a]	0,002-0,003
	Zinc (ZnO)[a]	0,003-0,012
	Manganese (MnO)[a]	0,007
	Cobalt (CoO)[a]	0,00007
	Silicon (SiO_2)[a,b,e]	0,016-0,101
Anions	Chloride (Cl)[c,e]	0,16-0,27
	Phosphate (P_2O_5)[b,c,d]	0,14-0,40
	Sulphate (as SO_3)[b,d]	0,17-0,52

a Sang *et al.* (1974)
b Fort and Smith (1952)
c Cheng *et al.* (1974)
d Honig (1953a)
e Alexander and Parrish (1953)
f Parrish (1953)

Organic acids

The organic acid composition of mixed juice may be divided into the non-nitrogenous acids (Table 4) and the amino (nitrogenous) acids (Table 5). Although comprising a small fraction, they are responsible for the natural pH of the juice

(5,2-5,4) as well as its buffering capacity (the ability to absorb large quantities of base such as lime with a small change in pH). This is due largely to aconitic acid which occurs at levels two to three times more concentrated than all the other acids combined ([1]unpublished data). The levels of lactic and acetic acid recorded are for normal, undeteriorated mixed juice. Acetic acid levels can increase three to four fold in diffuser juices under certain liming conditions (Schäffler *et al.*, 1988; Beckett and Graham, 1989). This is due to hydrolysis of acetyl groups from the hemicellulose fraction of bagasse at high pH. Lactic acid is a metabolite of thermophilic bacteria such as *Bacillus* and an indication of mill and factory sanitation. Acceptable levels are 300 ppm/Bx, with levels well over 1 500 ppm being recorded in infected juices (McMaster and Ravnö, 1975). Between one and four parts by weight of sucrose are considered lost for every part of lactic acid produced. The free amino acids and those found in protein are a result of direct extraction from the cane.

Table 4

Non-nitrogenous organic acids

Acid		Concentration (ppm/Bx)
Natural	Oxalic[a,b]	40-200
	Citric[a,b,c]	900-1 800
	Tartaric[a]	10-180
	Malic[a,b]	1 200-1 800
	Aconitic[a,b,c]	5 000-8 000
	Succinic[a,b]	100-200
	Glycolic[a]	trace-150
Formed during processing	Lactic[d,e]	250-670
	Acetic[d,f]	200-300

a Meade and Chen (1977)
b Honig (1953b)
c Celestine-Mytril and Parfait (1988)
d Schäffler *et al.* (1988)
e McMaster and Ravnö (1975)
f Beckett and Graham (1989)

Table 5

Amino acid composition

Compound		Free	% Dry solids Protein
Amides	Asparagine	0,71	
	Glutamine	0,19	
Amino Acids	Aspartic	0,11	0,06
	Glutamic	0,05	0,08
	Alanine	0,06	0,05
	Valine	0,03	0,04
	Aminobutyric	0,03	0,03
	Threonine	0,02	0,04
	Isoleucine	0,01	0,03
	Glycine	<0,01	0,04
	All others	trace	<0,03

Roberts and Martin (1959)

Other constituents

Other minor constituents in mixed juice consist of waxes, fats and phosphatides which are extracted from the rind and leaves of the cane and can constitute approximately 0,1% on brix. They are normally removed during clarification (Honig, 1953c). Colouring matter in mixed juice consists of a variety of organic compounds including chlorophylls, carotene, flavonoids and polyphenols. Common to all these classes of compounds is double bond unsaturation (the cause of the colour) leading to complicated reactions in the juice with some of the other consituents (Honig, 1953d).

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